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ABSTRACT

This paper lays out the characteristics of effective leadership in education, particularly science education. Teachers should be aware of different theories of instruction and apply them as student needs warrant. Quality supervisors and principals support teacher professional development, are effective communicators, encourage positive curriculum development, and set high standards for pupil achievement. Knowledgeable, skillful educational leaders should possess the ability to work successfully with others. (Contains 24 references.) (WRM)

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# Leadership in the Science Curriculum

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## LEADERSHIP IN IN THE SCIENCE CURRICULUM

Leadership is needed in schools to overcome problems in the school setting. Richardson and others (1989) emphasized that principals be proactive and not reactive persons. Thus problems tend to be identified before they happen rather than reacting to crises situations only. Ediger (1993) stressed the importance of administrators and supervisors being highly knowledgeable about the curriculum in providing for optimal learner achievement. Much parental dissatisfaction might well be avoided if leadership capabilities were used to guide each pupil to attain as much as possible.

### Knowledge of the Curriculum

To assist pupils to achieve as well as possible in the school setting, attempts need to be made to identify effective schools. This is indeed difficult. Wallberg (1979) identified more than 2,700 research studies that emphasized effective schools. Squires, Huitt, and Segar (1985) in summarizing research pertaining to effective schools raised the following questions:

1. Does the school leader have purpose in mind when administering and supervising in the school setting?
2. Are high academic standards being stressed?
3. Is the principal supportive of efforts in school improvement?
4. Are adequate staff development programs in evidence to improve the curriculum?
5. Do faculty and staff work together to harmonize endeavors in instructional improvement and discipline of learners.
6. Is the principal visible to observe teaching and learning as well as to confer with teachers on curriculum and instruction matters?

Questions arise here as to what is meant by school and curriculum improvement, having purpose in mind in making changes in the educational setting, as well as which inservice education programs to



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stress for faculty development. A need exists to make decisions based on theory. Something must provide direction and guidance in whatever is done in education, teaching, and learning. Writers frequently write about the necessity of theory guiding instruction. These writers tend not to state which theories should be emphasized in the curriculum. There are numerous recommendable psychologies and theories of instruction that can be emphasized in the school curriculum. I recommend strongly that all administrators, supervisors, and teachers become thoroughly familiar with each theory. Depth learning of each theory should be in the offing for educational leaders which includes classroom teachers. These theories have stood the test of time and tend to be classical in nature. I will discuss what I believe to be selected relevant theories of instruction which educational leaders must be able to implement in ongoing lessons and units of study.

## Theories of Teaching

Dewey (1916) emphasized problem solving approaches in teaching-learning situations. The problems need to be real and lifelike to pupils. Committee work to identify and solve contextual problems in a creative atmosphere was stressed. The teacher is a guide and resource person, not a dispenser of information.

In a science unit on "Animals Without Backbones," pupils individually or in a committee setting might identify problems such as the following based on ongoing learning opportunities:

1. How do sponges obtain food since they do not move around?
2. How do coelenterates, such as jelly fish and the Portuguese man-of-war, paralyze their prey?
3. How do parasites such as flatworms (platyhelminthes) obtain energy for living?

For each problem area identified, pupils may volunteer to serve on a committee to obtain solutions. A variety of reference sources need to be used to gather information in answer to the problem. The answer(s),

which are stated as hypotheses, are tentative and subject to testing.

Piaget (1950) stressed a developmental psychology by identifying four stages that most pupils go through as they progress from birth through the elementary school years. These developmental stages are sensorimotor (birth to two years of age), preoperational (ages two to seven), concrete operations (ages seven to eleven), and the stage of formal operations (age eleven and beyond). The ages given are approximate in Piaget's research findings.

For the sensorimotor stage of development , which is prior to the public school years, parents may provide models of animals without backbones. These young children may touch, feel, smell, see, and hear sounds of these models when they are being shaken.

At the preoperational stage of development, pupils may raise questions about the invertebrates being observed. Piaget, like Dewey, was strong on using problem solving methods of learning. At this stage of development, Piaget believed that pupils see one variable only or largely such as the length of the object only, or the width only. Comparisons may be too difficult for these preoperational pupils to make such as comparing annelids with platyhelminthes (flatworms) and nematodes (roundworms).

In viewing a videotape, preoperational pupils on the first grade level may notice and reflect upon annelids, such as the earthworm, having a segmented body, and a well developed nervous system. It then might not work for preoperational pupils to make comparisons among invertebrates. The pupils at the stage of concrete operations understand several variables at one time and yet the teacher needs to refer pupils to the concrete situation which are directly related to the abstract. Thus if pupils are studying mollusks, they need to relate abstract learnings (words, phrases, sentences, paragraphs, and diagrams) to the model

or real mollusks, including snails, slugs, oysters, and squids. From the concrete to the abstract would be a good model to follow here. Much use needs to be made of real objects and items in teaching pupils on the concrete stage of operations.

At the stage of formal operations, pupils with teacher guidance may discuss arthropods, for example, without referring to realia or concrete situations, according to Piaget. I would recommend, however, that learning activities should stress the concrete facets adequately. Content can become too abstract whereby learners individually do not understand what has been taught.

Maslow (1954) emphasized a theory of motivation with its hierarchy of needs that individuals should have fulfilled such as physiological (adequate nutritious food, clothing, and shelter); safety and security (a safe home and neighborhood, freedom from abuse), love and belonging ( acceptance in the home and school setting), esteem (being recognized for talent and/or skill) , and self actualization (becoming the kind of person desired). Personal needs of pupils must be met if they are to do well in school. Pupil- teacher planning of the curriculum is salient.
The objectives, learning opportunities, and appraisal procedures must meet needs of pupils in the science curriculum.

Bruner (1968) emphasized a structure of knowledge be identified for each curriculum areas. These structural ideas represent key ideas or major generalizations as perceived by academicians in science in their respective areas of expertise. Leaders in science education and teachers might well identify their own structure of knowledge to emphasize in teaching each curriculum area. Bruner's theory of instruction is practical since its implementation might well provide objectives, learning opportunities to attain the objectives, as well as evaluation procedures to ascertain learner progress. Methods of learning, according to Bruner, emphasize what the scientist would stress in a laboratory setting.

Behaviorism, as a psychology of learning, has a long history of importance (Bobbitt 1916, W.W. Charters 1923, B.F.Skinner 1979). Behaviorism stresses the importance of precise, measurably stated objectives for pupil attainment, written prior to instruction. Mastery learning, instructional management systems, and criterion referenced testing are present day examples of behaviorism. Reinforcement theory is also directly relate to behaviorism. The following are examples of behaviorally stated objectives for pupils to achieve:

1. The pupil will list in writing three regions of an insect and explain the purpose of each region.
2. The pupil will write a fifty word paragraph on differences between monerans and bacteria.
3. The pupil will state orally three differences and three likenesses of amphibians versus reptiles.

The science teacher may announce prior to instruction what pupils are to learn from a teaching/learning situation. This provides security to pupils when they know what is to be learned from an ongoing lesson or unit of study. Tests given are aligned with the precisely stated objectives. To provide reinforcement, based on test results, the science teacher may offer sincere praise to pupils for doing well. Ideally, the success rate for pupil learning is high since the teacher teaches directly for pupils achieving the stated objectives. The learning activities aligned with the objectives of instruction make for high validity. With objectives being stated so that pupils either do or do not attain success as a result of interacting with learning opportunities, little leeway is left for interpretation as to what any one objective means.

The basics (Bagley 1905, Bestor 1953, Smith 1959) in the curriculum also had a relatively long history in education. It has never been determined at any age in time what is basic for pupils to learn. Former President of the United States Ronald Reagan and his Secretary of Education William Bennett continually emphasized that teachers

should teach the basics and not waste time on the frivolous. They too did not define what the basics were that pupils should acquire. If we only could know what these are, much time would be saved in teaching learners. Too be sure, effort must always be put forth to determine what is basic and essential for pupils to achieve.

More is expected of administrators and supervisors than ever before. Knowledge of the curriculum is no exception. Missouri since 1985 with the Excellence in Education Act, among other states in the United States, mandates that principals evaluate each nontenured teacher at least once a year and tenured teachers at lest once every three years. This means that principals need to have knowledge of the curriculum when appraising teaching performance. Teachers will grasp how knowledgeable the principal is during an observation to the classroom followed with a conference. The purpose of observational visits and fillip conferences should be to improve the teaching of knowledge, skills, and attitudes of the classroom teacher.

Theories of learning to provide direction in teaching-learning situations differ from each other. What then can be done to assist teaches and administrators/supervisors in providing for optimal pupil attainment in the classroom? Determine which theory or theories benefit individual learners in teaching and learning. Pupils differ much from each other and need guidance to learn as much as possible. Since pupils are human beings and are different one from the other, it behooves educational leaders to determine which theory in use will assist the pupil to attain as optimally as possible.

## Functions of the Educational Leader

Leaders in education must emphasize the importance of good human and public relations (Shoemaker and Fraser 1981). Principals and supervisors need to assist teachers to have pupils achieve goals. Assisting teachers can largely be done if their is mutual respect and acceptance between the leaders and the teachers. Hindrance in quality communication among participants results in a lack of sharing ideas,

results, and work completion in the school setting. Oliva (1984) stresses careful attention be given to methods of nonverbal, written, and verbal communication skills.

Gestures, facial expressions, and body movements do convey something to the receiver of nonverbal communication. A friendly countenance emphasizing a willingness to work together and collaborate on salient tasks to improve the science curriculum are musts. People realize rather quickly in most cases in which selected individuals indicate nonverbally that they do not wish to serve on a committee, nor give the time to do so, nor indicate feelings of cooperation in moving toward an ideal or have a vision of what should be accomplished in the school setting. The educational leader must present a role model here. The principal/supervisor sets examples for teachers to follow. His/her enthusiasm, knowledge, empathy, and understanding of teachers as human beings having much worth should be an inherent facet of the nonverbal role model. Written communication skills are further needed by the educational leader to convey, clarify, and confirm meaningful information to teachers be it in a bulletin, E-mail, or Fax pertaining notices of staff development, in trends in teaching for teachers to think about, as well as issues in the curriculum. Modern technology has made it so that word processors make the act of written communication easier, neater in the final copy, and more flexible in making revisions and modifications. Mechanical errors must be omitted in all written messages used to communicate to receivers of the message.

Verbal communication must be comprehendible with appropriate stress, pitch, and juncture used to convey information to others. Quality eye contact is a must in verbal communication. Ellis (1986) wrote that, in terms of research results from the studies of William Rutherford and associates, the most successful principals clearly communicated expectations, provided technical assistance, and monitored the results.

Being able to communicate well comes up again and again in research results pertaining to educational leaders. Hallinger and Murphy (1986) in emphasizing effective school research summaries list

the following as being salient:

1. determining and communicating the goals of the school.
2. supervising and evaluating teaching and learning.
3. coordinating curriculum efforts.
4. developing high standards in the academics as well as high expectations.
5. monitoring and evaluating student achievement.
6. encouraging professional development of teachers.
7. maintaining time on task for instruction.
8. developing incentives for teachers and students.

Stocklinski and Miller- Colbert (1991) emphasize the Comer Process, a research based model for school improvement that has as its basis collaboration, consensus, and communication for the solving of problems in academic, social, and staff development areas. This process permits teachers, supervisors/principals , and parents to harmonize efforts in working together for the good of the pupil. Among other items of importance here is the emphasis placed upon quality communication to achieve goals of the school and of education.

## Traits and Characteristics of Principals

More is expected in a complex society than ever before of school supervisors and administrators

Duttweiler and Hord (1989) state that educational leaders who are effective desire a participatory style of supervision. These principals and supervisors want input from others, particularly teachers. Thus there needs to be collaboration skills in working together for the good of the student. Skills in being able to foster cooperation among participants in selecting objectives of instruction, learning opportunities to attain the objectives, and evaluation procedures to assess progress are desired from school leaders. These leaders need to be able to motivate, encourage, and stimulate others in the school setting to participate in school improvement endeavors. Thus principals and

supervisors should be skillful in working effectively with others to achieve the goals of the school. An open school environment assists participants to become actively involved to improve the total school curriculum.

Society is continually changing. It does not stay stable. With the many societal changes, the school curriculum also needs modification and revisions. The world of work and the personal needs of individuals require that student competencies need developing in the areas of creative thing, problem solving, critical thinking, as well as reasoning skills (Dede 1989). Educational leaders should think of change as being relevant in society. These changes have tremendous implications for objectives and goals in the curriculum, learning opportunities to attain the stated ends, and assessment procedures to determine how much pupils have learned and what is left to be done to guide more optimal learner attainment.

The new leader in the school setting must be

1. highly knowledgeable of workable procedures of teaching.
2. an effective leader possessing skills to work with others.
3. able to motivate teachers and others in the school setting.
4. proficient in curriculum development.
5. knowledgeable of child development characteristics.
6. proficient in a variety of communication skills.
7. skillful in interpersonal relations.
8. able to plan and implement decisions made through collaboration.
9. knowledgeable of societal trends and quality school practices.
10. able to apply technology to instruction and management.
11. skillful in the use of political processes to attain objectives of instruction.
12. knowledgeable about school site management and its implementation.
13. secure parental cooperation and input.
14. obtain information to use in making relevant decisions.

15. empower individuals, especially teachers, in a rich school cultural climate.

School leaders need to provide opportunities for science teachers to try out new ideas in ongoing lessons and units of study. Thus, science teachers with supervisor leadership may wish to assist pupils in new ways to develop rich science vocabularies. Condrey (1996) wrote the following:

Every science teacher knows that showing students how concepts apply to everyday events is quite a challenge. We describe real world applications in class, conduct demonstrations to illustrate concepts in action, and give students applications they can replicate in the lab. Yet they still have difficulty connecting classroom activities to their own lives.

We could spend hours previewing videos in search of the perfect visual to illustrate concepts germane to teenagers' lives. A better idea is to provide them the opportunity to produce a video that illustrates concept applications from their own experiences.

Student teams can design and produce three to five minute instructional videos that define a concept and apply it to their personal experiences. For example, physics students might film applications of inertia in skating or stock car racing: biology or anatomy students might show how a gymnast's muscles work together to perform a maneuver on the parallel bars; or chemistry students might produce a video illustrating the effects of chemical reactions in food preparation. Making these videos helps students to see the connections between science and "real life" by taking the experience out of the classroom and putting it into their personal areas of knowledge and relevance.

Producing a short video involves much more than haphazard filming. The purpose is to define and illustrate the application of a specific concept, so the video should be instructive and follow a logical sequence. It must be able to stand alone without further explanations from the presenters. Students should be encouraged to to use creativity and humor in their productions.

## In Summary

Foresight of educational leaders is vital so that a vision of the ideal is possible. Efforts need to be made to achieve the vision. It is an ongoing process. Much knowledge of the curriculum is necessary to

attain and grow. Purposes need to be involved in moving from what is to what should be. The educational leader needs to provide support to those working toward positive changes in curriculum improvement. Staff development is needed in making these changes. Collaboration among participants is necessary to work toward a desired curriculum.

Diverse theories of instruction that have stood the test of time may be used by teachers to guide pupils to achieve as much as possible. The theory used must harmonize with what assists the learner(s) to attain and achieve. Each theory provides the teacher guidance and direction in making educational decisions.

Quality supervisors/principals are able to communicate well with others. Diverse forms of communication must be used to achieve purposes in the school setting. The goals and objectives of the school need communicating to parents and the lay public. Learning opportunities being emphasized in the school setting should harmonize with quality goals and objectives. Monitoring of learner progress in goal attainment is a must. There need to be high standards for pupil achievement with time on task involved. Incentives for learning and for teaching should be in the offing.

Society changes rather continuously making it necessary for the school curriculum to change. Higher levels of cognition must be stressed in teaching-learning situations. Knowledgeable, skillful leaders should possess abilities to work effectively with others, especially teachers. These leaders must be proficient in curriculum development procedures. Child growth and development characteristics should be used in improving teaching and learning. Good interpersonal relations are needed to guide staff development efforts as well as involve parents in matters pertaining to curriculum improvement.

There are principles of learning from educational psychology which teachers and educational leaders tend to agree with. These principles of learning provide guidance in choosing objectives of instruction, learning opportunities for pupils to achieve the objectives, as well as appraisal procedures to ascertain what pupils have learned. Ediger (1994) lists

these principles of learning as follows:

1. pupils need to attach meaning and understanding to ongoing lessons and units of study.
2. pupils need to experience interest in learning.
3. pupils need to perceive purpose in learning.
4. pupils need to experience sequence in learning opportunities.
5. pupils need to experience rational balance among objectives in the curriculum, such as knowledge, skills, and attitudinal goals.

The long range goal of educational leaders is to assist teachers in guiding pupils to achieve more optimally. Supervisors/principals need to challenge teachers to provide the best curriculum possible for pupils in the school setting. Ward, et. al. (1996) wrote the following:

As students continue to explore the observations and relationships found in the above activities, the teacher guides students to "construct" the concept that air expands when heated and contracts when cooled. The teacher then provides opportunities for pupils to apply that concept to new situations in which differences in air pressure are caused by the temperature changes.

Providing a classroom environment that encourages collaborations among students is an important component of a constructivist classroom environment. When teachers use questions that probe, clarify, and explore the relationships between student's prior experiences, students develop more accurate science concepts.

Students within this classroom environment change from passive receptors to active learners responsible for their own construction of meaning. The challenge for teachers is how to help students effectively construct meaning. Teachers continued to be responsible for selecting which science concepts to study and how their students learn these concepts. Within a constructivist environment , however, these decisions are based to a much larger degree on the abilities of teachers to know what their students bring to the classroom. When teachers are attuned to students' prior knowledge, they enable students to accommodate their previously held "understandings" by providing experiences that develop increased understanding of science concepts.

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